What Powertech said about the proposed geochemical model:
Powertech requests replacing post-restoration groundwater monitoring with geochemical modeling using site-specific data, as requested in Attachment A-3.

Comments on permit section
II.G. Additional Requirements to Obtain Authorization to Inject for Burdock Wellfields 6, 7 and 8

Powertech proposes to conduct geochemical modeling using site-specific data rather than column testing to demonstrate that no ISR contaminants will cause a violation of MCLs or otherwise adversely affect human health, outside of the exempted aquifer for Burdock Wellfields 6, 7 and 8. Attachment A-3 to Powertech's Class III comments provides explanation of the relative advantages of geochemical modeling to column testing.

Attachment A-5 Powertech's Class III comments proposes an alternate solution to column testing and Attachment A-3 includes the explanation of geochemical modeling proposed in place of laboratory bench-scale testing to demonstrate that contaminants will not cross the down-gradient aquifer exemption boundary and cause a violation of any primary MCLs or otherwise adversely affect the health of persons.

In addition to the justification provided in Attachment A-3, Powertech asserts that geochemical modeling should be used rather than column testing or other laboratory-scale bench testing to evaluate the potential impact of the partially oxidized groundwater down-gradient from Burdock Wellfields 6, 7 and 8 for the following reasons:

1. EPA appears to be focused exclusively on the attenuation capacity down-gradient of the wellfield, whereas the key for successful groundwater restoration is to demonstrate the aquifer's capacity to maintain stability within the wellfield to prevent uranium and other constituents from remobilizing. As described in Attachment A-3, EPA has concluded that geochemical modeling can be used to provide a "defensible demonstration" that these criteria are met. Powertech is not aware of column testing being used on any ISR projects to make this demonstration.
2. Unlike column testing, geochemical modeling has the ability to evaluate how much oxygen will remain in the wellfield following groundwater restoration. As described on p. 197 of the Dewey-Burdock Safety Evaluation Report (SER, Exhibit 014 at 197):

> In assessing the potential for groundwater restoration, the staff reviewed a geochemical modeling report on the Dewey-Burdock site prepared by the USGS, under contract by the USEPA (Johnson, R. H., 2011). In its published work to date, USGS determined that the amount of oxygen remaining in the aquifer (production zone) after restoration is a key factor in stability. If some oxygen remains in the production

zone, "some uranium is found in the groundwater." If no dissolved oxygen remains then "uranium is not found in solution."

3. Unlike column testing, geochemical modeling has the ability to evaluate the potential impact of reductant addition during groundwater restoration. Although Powertech's NRC license does not currently authorize reductant addition, the license could be amended if needed to permit injection of sodium sulfide or another suitable reductant to deplete any oxygen remaining after groundwater restoration.
4. Unlike column testing, geochemical modeling based on site-specific data has the ability to assess how much reducing or attenuation capacity remains down-gradient from these wellfields. The fact that the uranium roll fronts have not migrated further down-gradient indicates that reducing capacity still exists.

Powertech's proposed permit language:
II.G. Additional Requirements to Obtain Authorization to Inject for Burdock Wellfields 6, 7 and 8

1. Because the Chilson Sandstone down-gradient from Burdock Wellfields 6, 7 and 8 has been partially oxidized by native groundwater, the Permittee shall evaluate the capacity of the down-gradient Chilson Sandstone to remove residual contamination from restored wellfield groundwater as it travels down-gradient toward the aquifer exemption boundary.
2. To fulfill this requirement the Permittee shall:
    a. Conduct geochemical modeling using site-specific data to demonstrate that contaminants will not cross the down-gradient aquifer exemption boundary and cause a violation of any primary MCLs or otherwise adversely affect the health of persons.
    b. Conduct column testing, batch sorption testing, or other approved laboratory or field testing method to provide site-specific inputs into the geochemical modeling, as specified in Part IV, Section D.1.a.
    c. Submit geochemical modeling results to the Director demonstrating that no ISR contaminants will cross the down-gradient aquifer exemption boundary and cause a violation of any primary MCLs or otherwise adversely affect the health of persons.
3. [my language they left in place] 3. If, during the wellfield pump tests using a pumping rate simulating production and restoration in Burdock Wellfields 6, 7 or 8, the Chilson aquifer potentiometric surface is drawn down to the point where the proposed injection interval becomes less than fully saturated, the Permittee shall develop a 3-D unsaturated groundwater flow model for the area where less than fully saturated conditions are anticipated.

Comments related to permit section
PART IV. DOWN-GRADIENT COMPLIANCE BOUNDARY BASELINE MONITORING AND POST-RESTORATION MONITORING PLAN

Please refer to Attachment A-3 for a proposed alternate solution to post-restoration groundwater monitoring. In the event that post-restoration monitoring is required, please refer to Attachment A-2 for a proposed alternate solution for locating Down-Gradient Compliance Boundary Monitoring Wells and Attachment A-4 for a proposed alternate solution to establishing initial baseline values and updating baseline values for Down-Gradient Compliance Boundary Monitoring Wells.

Attachment A-3 includes comments regarding the proposed post-restoration groundwater monitoring requirements.

Powertech's proposed permit requirement:
Part IV. POST-RESTORATION GEOCHEMICAL MODELING REQUIREMENTS

A. Geochemical Modeling to Verify Attenuation Capability of Down-gradient Injection Zone Aquifer

Please refer to Attachment A-5 for a proposed alternate solution to column testing, Attachment A-3 for a proposed alternate solution to post-restoration groundwater monitoring, and Attachment A-1 for a proposed alternate solution to collecting core samples during wellfield development. Powertech proposes to conduct geochemical modeling using site-specific data rather than column testing to demonstrate that no ISR contaminants will cause a violation of MCLs or otherwise adversely affect human health outside of the exempted aquifer.

Attachment A-5 includes comments regarding proposed column testing requirements.

A. Geochemical Modeling to Verify Attenuation Capability of Down-gradient Injection Zone Aquifer

1. Once wellfield restoration and stability monitoring have been completed in a wellfield, the Permittee shall conduct geochemical modeling using site-specific data to demonstrate that contaminants will not cross the down-gradient aquifer exemption boundary and cause a violation of any primary MCLs or otherwise adversely affect the health of persons.
    a. Geochemical modeling shall evaluate the following:
        i. Demonstration of the restored aquifer's capacity to maintain stability, considering the long-term influence of up-gradient groundwater.
        ii. Assessment of the natural capacity of the down-gradient portion of the exempted aquifer to attenuate contaminant concentrations.
        iii. Evaluation of any localized, elevated concentrations above the restoration criteria remaining in the production zone following restoration.
    b. The Permittee shall submit a Closure Plan to the Director for approval describing the geochemical modeling results. The plan shall demonstrate that no ISR contaminants will cross the down-gradient aquifer exemption boundary and cause a

violation of any primary MCLs or otherwise adversely affect the health of persons. The geochemical model shall be calibrated with site-specific data.

Proposed Alternate Solution to Core Sampling

As described in Attachment A-3, Powertech proposes to conduct geochemical modeling using site-specific data to evaluate the geochemical stability of the production zone and the possibility that contaminants could be released from the restored production zone to the aquifer exemption boundary and cause a violation of MCLs or otherwise adversely affect human health. Powertech requests that such site-specific data not be limited to column testing using core samples, since that would not allow Powertech to take advantage of advancing research methodologies. The geochemical modeling procedures and collection of site-specific data would be documented in the Closure Plan, which would be submitted to EPA for review and approval.

Closure Plan

Powertech requests the ability to prepare a Closure Plan that will be submitted to EPA for review and approval following NRC approval of groundwater restoration in the first wellfield. The Closure Plan will be updated or a new Closure Plan prepared for each subsequent wellfield. The Closure Plan will document groundwater restoration efforts, stability monitoring results, and NRC correspondence during the approval process. This would include documentation of NRC staff's rigorous review process for any ACLs to determine that the ACL does not pose a potential hazard to human health or the environment. As described in Appendix B of the NRC SEIS, this review process includes three risk assessments:

1) a hazard assessment to evaluate the radiological dose and toxicity of the constituents in question and the risk to human health and the environment;
2) an exposure assessment to examine the existing distribution of hazardous constituents, potential sources for future releases and potential consequences associated with the human and environmental exposure to the hazardous constituents; and
3) a corrective action assessment to identify the preferred corrective action to achieve the hazardous constituent concentration that is protective of human health and the environment (Exhibit 008 at p. B-1).

Following the completion of each major wellfield area (i.e., the Dewey area or the Burdock area), the Closure Plan will be updated to include **an integrated hydrologic and reactive transport (geochemical) model encompassing all restored wellfields in that area**. The model will evaluate the geochemical stability of the production zone and the possibility of release of constituents from the restored production zone to the aquifer exemption boundary.

Commented [SV1]: Does this include stability of non-ACL constituents?

Geochemical modeling using site-specific data would be far superior to post-restoration groundwater monitoring to demonstrate that there will be no threats to human health or the environment at the aquifer exemption boundary. Following are specific advantages to the requested modeling approach:

1) Geochemical modeling is the state of the art approach to demonstrate that there will be no detrimental impacts at the aquifer exemption boundary as part of the ACL application process to NRC for NRC-licensed ISR facilities. This is supported by the following statements by EPA in the previously proposed but discarded 40 CFR part 192 rulemaking:
    a. "Geochemical modeling can provide a defensible demonstration of an aquifer's natural capacity to maintain stability, which statistics alone cannot provide." (Exhibit 007 at p. 4172)
    b. "We believe that modeling … can provide confidence that a geochemical environment exists to prevent uranium and other constituents from remobilizing …" (Exhibit 007 at p. 4177)
    c. "Background data are also needed for geochemical modeling of the groundwater in the production zone and downgradient to support assessments of the natural capacity of the restored production area and downgradient portion of the exempted aquifer to maintain long-term stability of the restored wellfield." (Exhibit 007 at p. 4174)

    NRC staff also performed geochemical fate and transport modeling as part of its review of the groundwater restoration report for the Christensen Ranch Project (now part of the Willow Creek ISR Project) in Wyoming (Exhibit 020). The fact that NRC staff did not approve restoration as requested by the operator speaks to the detailed level of review that each ISR wellfield will undergo before receiving NRC approval of successful groundwater restoration.

2) The Closure Plan will provide the ability to evaluate various scenarios related to restoration activities, as well as monitoring strategies and remediation options if required. It would not require decades or centuries to determine whether groundwater restoration efforts are adequate to protect groundwater quality at the aquifer exemption boundary.

For example, consider the scenario where post-restoration groundwater monitoring is required by EPA and that monitoring detects a statistically significant increase after 30 years of post-restoration groundwater monitoring. Based on comment #A-3-1, this would not be an unusual monitoring duration under natural groundwater flow conditions. It is very likely that it would necessitate restarting groundwater restoration efforts in that wellfield. Not only would this be a monumental task in terms of restarting equipment (pumps, pipelines, reverse osmosis units, etc.) that had been idle for decades, but it would necessitate another 30 years of monitoring to see whether the additional groundwater restoration corrected the issue. This lag between adjusting the independent variable (groundwater quality within the wellfield) and determining the resulting

Commented [SV2]: If we can't quote the FR notice, can we use the Tech Background Report?

change in the dependent variable (down-gradient water quality) makes post-restoration groundwater monitoring technically infeasible. Instead, geochemical modeling would provide predictive concentrations of **all constituents of concern** at the aquifer exemption boundary at the close of groundwater restoration. This would provide the EPA with the opportunity to review the model and determine whether groundwater would be adequately protected at the aquifer exemption boundary. This review would occur within months of the end of groundwater restoration stability monitoring instead of decades later. If it is determined that additional groundwater restoration efforts are needed or monitoring is required to verify model assumptions, those could be performed relatively quickly and additional assessment performed until EPA is satisfied.

Commented [SV3]: Does Powertech see this as not just ACLs but all COCs?

3) Geochemical modeling is already required by the Draft Class III Area Permit. Part IV, Section D.1.e requires "geochemical modeling results demonstrating that no ISR contaminants will cross the down-gradient aquifer exemption boundary" if column testing does not prove that there will be a sufficient decrease in ISR contaminant concentrations. Based on the very narrow definition of what would entail adequate column test results (i.e., no statistically significant increase in the concentration of any constituent during the second set of tests), it is a virtual certainty that geochemical modeling would be required under the draft permit conditions. Further, the draft permit condition requires the model to demonstrate that no ISR contaminants will cross the down-gradient aquifer exemption boundary.
4) The modeling would be based on site-specific data. This could include a variety of data sources such as laboratory testing (e.g., batch sorption testing or column testing), field testing (e.g., cross-hole testing) or other methods. Due to the recent advancements in research technologies, Powertech does not propose to limit the data collection methods to any one method, but proposes to include site-specific data in the Closure Plan, which would be provided to EPA for review and approval.

Under Proposed Alternative Solution to Column Testing:

As described in Attachment A-3, Powertech requests the ability to prepare a Closure Plan that would include geochemical modeling using site-specific data to demonstrate that no ISR contaminants will cross the aquifer exemption boundary and cause a violation of MCLs or otherwise adversely affect human health. Powertech requests the ability to use column testing, batch sorption testing, or any other approved laboratory or field testing method to provide the site-specific inputs for geochemical modeling, should they be needed to support geochemical modeling efforts. Such tests would not be used as a stand-alone demonstration of the down-gradient natural attenuation capacity, but would be an integral part of the geochemical modeling. Powertech requests the flexibility to use synthesized groundwater representative of parameters and concentrations in the restored wellfield for such testing, should it be needed to support geochemical modeling efforts. Powertech also requests that rather than using unrestored groundwater for testing, geochemical modeling would evaluate any hot spots identified during stability monitoring, in accordance with NRC license requirements.

Powertech refers to methods used in recent studies on natural attenuation of uranium at ISR facilities, including both Raymond Johnson papers cited in the fact sheet. In those cases, laboratory testing (batch sorption testing, column testing, or other methods) was used to establish site-specific inputs for geochemical modeling (i.e., sorption site density). Those studies recognize that one core sample would not have the attenuation capacity to prove that there is a "sufficient decrease in contaminant concentrations after passing through the columns" without geochemical modeling. Instead, the laboratory studies are used to inform geochemical modeling, which would be used to determine whether there is adequate natural attenuation capacity down-gradient to prevent contaminants from crossing the aquifer exemption boundary.